VIIRS PRODUCT EVALUATION AT THE OCEAN PEATE

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ABSTRACT

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) mission will support the continuation of climate records generated from NASA missions. The NASA Science Data Segment (SDS) relies upon discipline-specific centers of expertise to evaluate the NPP data products for suitability as climate data records. The Ocean Product Evaluation and Analysis Tool Element (PEATE) will build upon well-established NASA capabilities within the Ocean Color program in order to evaluate the NPP Visible and Infrared Imager/Radiometer Suite (VIIRS) Ocean Color and Chlorophyll data products. The specific evaluation methods will support not only the evaluation of product quality but also the sources of differences with existing data records.

Index Terms— Remote sensing, Radiometry

1. INTRODUCTION

The Visible and Infrared Imager/Radiometer Suite (VIIRS) is an instrument that will be flown on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP). VIIRS is a multi-disciplinary sensor that will be used to generate Atmosphere, Land and Ocean products.

The Ocean Product Evaluation and Analysis Tool Element (PEATE) is a component of the NASA Science Data Segment (SDS). The SDS is a distributed facility comprising a central Science Data Depository and Distribution Element (SD3E) and multiple, discipline-specific PEATEs. The PEATEs are tasked with acquisition of the NPP science data products and supporting the evaluation of the products by the NASA science teams. The Ocean PEATE is being supported within the existing Ocean Biology Processing Group (OBPG) at NASA Goddard Space Flight Center (GSFC).

2. DATA PRODUCTS

The data products will be generated by the Interface Data Processing Segment (IDPS) at the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) and delivered to the other NPP segments. The products will be acquired either directly from the IDPS or from the NOAA Archive Data Segment / Comprehensive Large Array Stewardship System (ADS/CLASS).

The NPP data products will be generated and delivered at three levels: unprocessed packet data as Raw Data Records (RDRs), unpacked and calibrated instrument data as Sensor Data Records (SDRs), and retrieved geophysical parameter data as Environmental Data Records (EDRs). The purpose of the PEATEs is to assess the quality of the EDRs to determine whether they can serve as Climate Data Records (CDRs). This includes both evaluating the EDRs generated by IDPS and recommending improvements to the science algorithms used in the operational software. The Ocean EDRS are Ocean Color and Chlorophyll (OCC) and Sea Surface Temperature (SST).

3. PRODUCT EVALUATION METHODS

The Ocean PEATE uses the capabilities of the GSFC Ocean Data Processing System (ODPS). The ODPS performs automated data acquisition and ingest, product generation, archiving, and distribution for satellite science data products. It currently supports Ocean Color and SST products for multiple active and heritage missions.

The methods used to evaluate the VIIRS Ocean EDRs, and particularly the OCC EDR, will be based on the techniques developed for the active sensors: the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and the Moderate-resolution Imaging Spectroradiometer (MODIS) [1],[2]. These methods employ a multi-pronged approach that includes evaluation of both the SDRs and EDRs. In addition, the EDRs will processed to Level-3 global products on daily and longer time scales to support time-series analyses and comparisons with other data sets.

The comparisons between VIIRS EDRs and OBPG products will be performed in stages, in order to isolate the causes of any differences (e.g., sensor calibration or product algorithm). The primary source of "truth" products will be the MODIS instrument on the Aqua satellite. The first step will be to perform a direct comparison of the VIIRS EDRs with the Aqua MODIS Level-2 products from the same day, as illustrated in Figure 1.

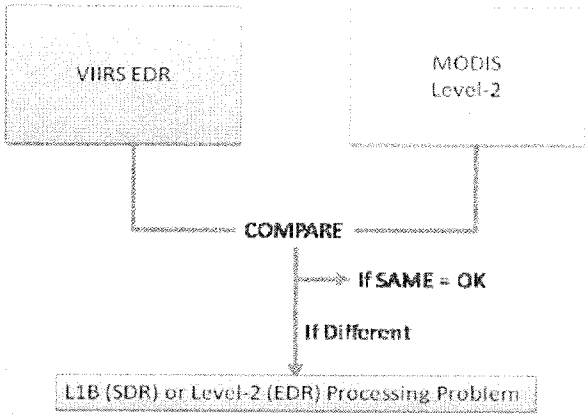

Figure 1. Direct comparison of VIIRS EDRS with MODIS Level 2 products.

If differences found in the Level-2 comparisons, the next step will be to process both the EDRs and the Level-2 products to generate Level-3 global products for the same time periods. (Figure 2). This will allow a direct comparison of the geophysical parameters for the same geographic locations.

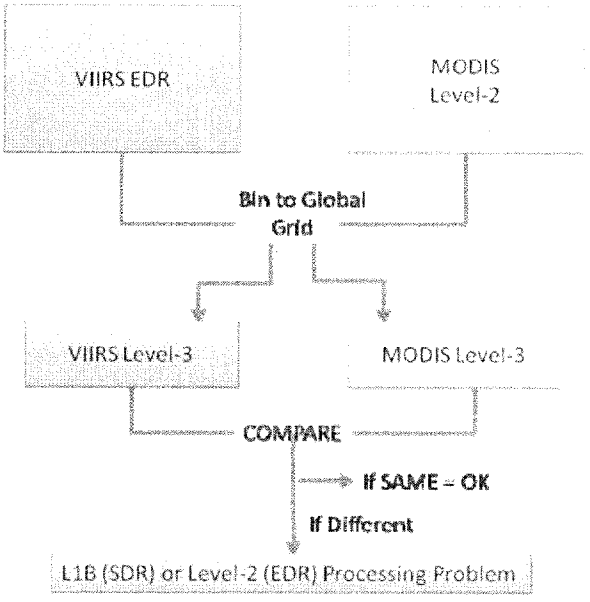

Figure 2. Comparison of Level-3 Products Generated from VIIRS EDRs and MODIS Level-2 Products.

If differences are still found in the Level-3 comparisons, the third step will be to process the VIIRS SDRs using the current OBPG Level -2 processing software (Figure 3). This will remove possible differences between the algorithms as a variable, in order to determine whether the SDR calibration is a source of differences.

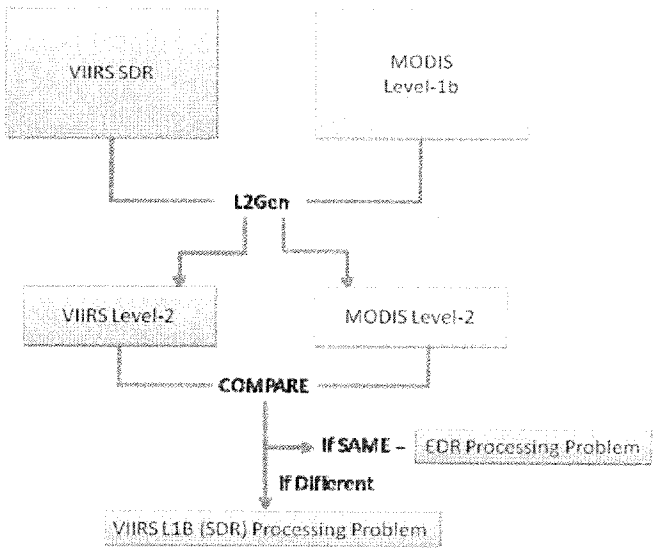

Figure 3. Comparison of VIIRS SDRs and MODIS Level-1B Products generated using the OBPG Level-2 Processing Software.

If the VIIRS and MODIS Level-2 products generated in this step agree, this indicates that the differences found in the previous steps are caused by algorithm differences; if not, differences in the calibrated radiances (VIIRS SDR vs. MODIS Level-1B) are affecting the comparisons.

The specific methods to be used for evaluations of the VIIRS SDRs and EDRs are described below.

3.1. SDR Evaluation

For the SDR evaluation, the Ocean PEATE will support the NPP Instrument Characterization Support Team (NICST), which is the NASA lead organization for VIIRS calibration. Specifically, the Ocean Team will collaborate with the NICST in the analysis of the on-orbit calibration data from the solar diffuser and the measurements collected for the lunar calibration. This follows the approach being used for MODIS, which involves close cooperation between the Ocean and Calibration teams [4].

The long-term temporal response of VIIRS will be determined using solar diffuser and lunar calibrations, as for MODIS and SeaWiFS. Figure 4 illustrates the temporal response of the SeaWiFS bands as determined from the lunar calibrations.

3.1. EDR Evaluation

The evaluation of the EDRs will be twofold. First, the data will be matched with *in situ* measurements of radiometry, chlorophyll and Inherent Optical Properties (IOPs). These data are collected from field programs, analyzed and archived in the SeaWiFS Bio-optical Archive and Storage

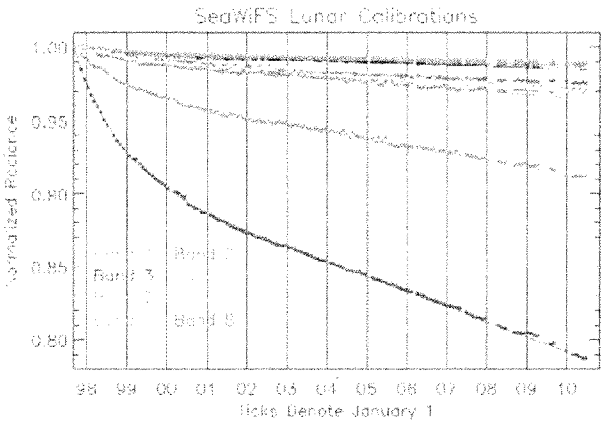

Figure 4. SeaWiFS Lunar Calibration Temporal Response Trends.

System (SeaBASS) developed and maintained by the OBPG. The results of in-situ matchup comparisons for SeaWiFS are shown in Figure 5.

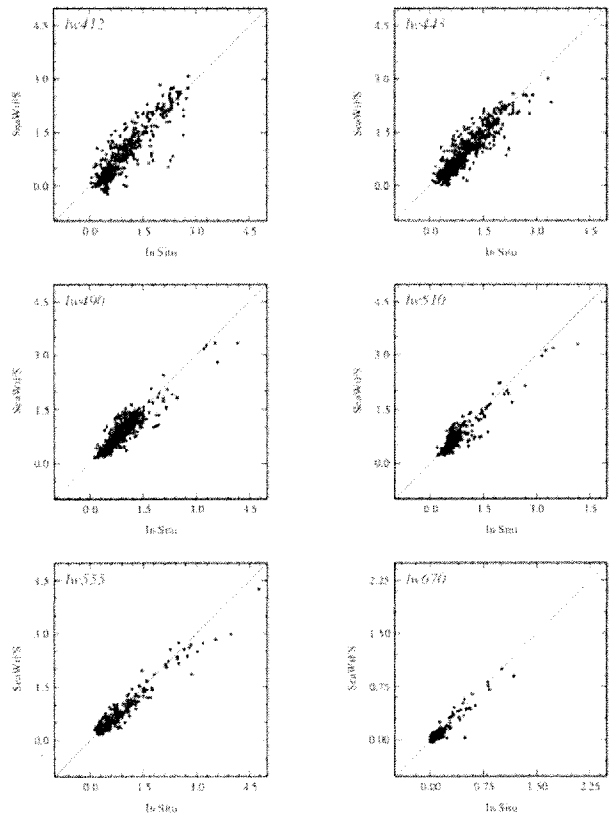

Figure 5. SeaWiFS In-Situ Matchup comparisons.

Second, the data will be cross-calibrated against Level-3 products, either from VIIRS or other sensors, to characterize detector- and scan-based artifacts in the data products [3]. The results of detector and scan-angle analysis for Aqua MODIS are shown in Figures 6 and 7.

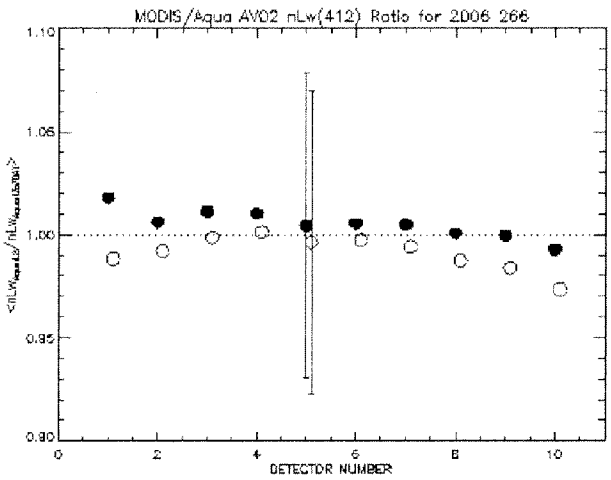

Figure 6. MODIS Cross-Calibration Results Vs. Detector Number.

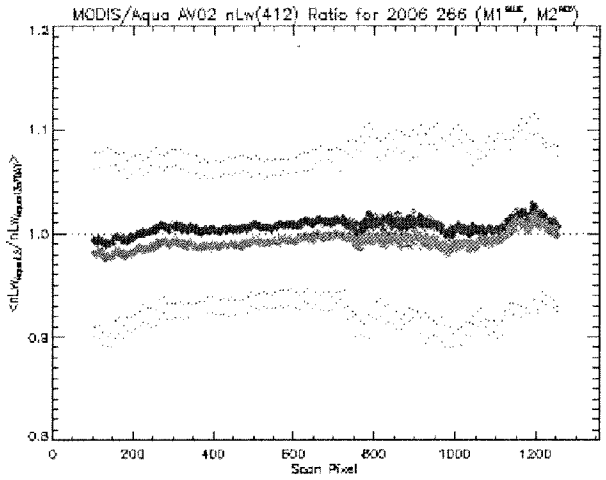

Figure 7. MODIS Cross-Calibration Results Vs. Pixel.

The Level-3 global products support a variety of long-term evaluations and are critical for the evaluation of the long-term consistency of the EDRs. Like the EDRs, the Level-3 products will be evaluated in multiple ways. The individual fields in the products will be compared with the same parameter generated from other sensors to evaluate their consistency, on global, regional and zonal scales. The same technique will applied to analyze the effects of algorithm changes under consideration, using products generated using both the old and new algorithms. In addition, temporal anomaly analysis will be performed on the Level-3 products to evaluate their long-term behavior. A typical mission-long Level-3 product comparison between Aqua MODIS and SeaWiFS is illustrated in Figures 8 and 9.

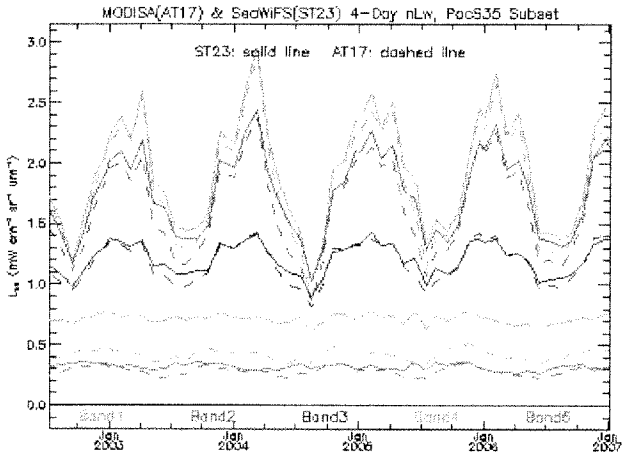

Figure 8. Mission-long Zonal Trends for Aqua MODIS and SeaWiFS.

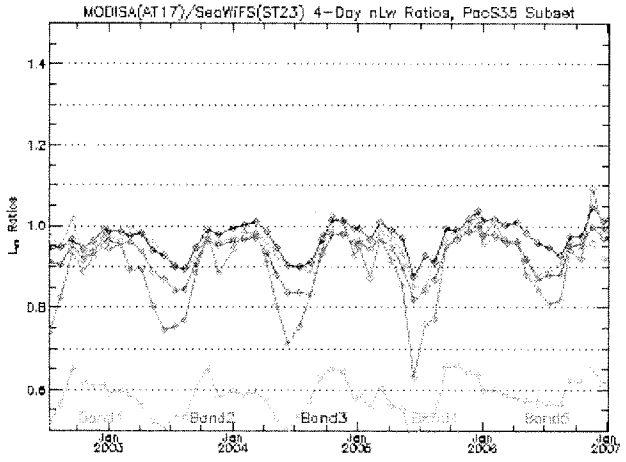

Figure 9. Mission-long Zonal Ratios for Aqua MODIS and SeaWiFS.

4. CONCLUSION

The OBPG has developed a proven set of tools and techniques for performing comprehensive assessment of Ocean Color data product quality and consistency, and the ODPS provides a highly capable computing environment to support these activities. By applying all of these methods and capabilities, the Ocean PEATE will support a rigorous evaluation of the VIIRS Ocean EDRs by the NASA Ocean Science Team.

5. REFERENCES

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